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Mr. Joseph Zimmerman
Kentucky Department of Fish & Wildlife Resources
1 Sportmans Lane
Frankfort, Kentucky 40601

Subject: Schultz Creek Restoration

Dear Mr. Zimmerman:

For your use, we have included herewith our responses to the comments from the Kentucky Division of Water, dated, September 2, 2009.

Bullet 2 Please provide a description of the recurrence interval ($Q_{1.5}$? Q_2?) used in the discharge values derived from the regression equations provided under section 5.2.1.

$Q_{1.5}$ represents the discharge (Q) with a 1½-year recurrence interval (which most closely approximates the bankfull event). Q_2 represents the discharge with a 2-year recurrence interval.

Bullet 3 Section 7.2.1 states that "an undisturbed reference reach for dimension, pattern, and profile could not be found in close proximity to the project site." However, in Section 7.2.1.4, it is stated that "Bedform will be diversified…mimicking those characteristic(s) of the reference reaches." Please explain this.

The bedform diversity characteristics that we are trying to "mimic" are from reference reaches in other places (beyond the local watershed) which have the same stream type, similar slope and bed material as the project design reach. Unlike regional curves, reference reaches need not come from the same hydro physiographic region (Hey, 2006).

Bullet 4 It is assumed that the shear stress values provided under 7.3.1.1 were calculated at a "bankfull event," but this is not stated explicitly. What depth of water was used in these calculations? Does this correspond to a "bankfull event?"

Yes, the shear stress values were calculated using the hydraulic radius (similar to mean depth) and slope that is associated with the bankfull discharge.

Bullet 5 Given that Sycamore (Platanus occidentalis) frequently volunteers on disturbed sites, we recommend that you consider substituting another species in the planting plan.

Sycamore shall be replaced with either, White Oak, American Beech, or Black Cherry.

Bullet 6 Please clarify the following statement under Section 9.3: "Of the 10 percent allowable invasive trees, honeysuckle and Osage orange are excluded." Does this mean that the presence of an individual of either of these species will require immediate removal, and their continued presence would constitute a failure to achieve success criteria?

The problem with many of the honeysuckle species is that they are very competitive. These shrub-like species are fast growing and vine-like, allowing them to take over and disturb surrounding native vegetation, saturating and dominating them, and blocking necessary sunlight due to the density of the vine mats created. Japanese Honeysuckle is on the KY Exotic Pest Plant Council's Severe Threat list (www.se-eppc.org). If this species is noticed during any site visits or monitoring, it shall be manually removed, attempting to remove the root and rhizomes from the soil. If the species persists on subsequent visits, chemical treatments may need to be used to irradiate the species. By the last monitoring year, honeysuckle should not be present at the mitigation site in order to be successful.

The osage orange (Hedge) trees are native to Oklahoma and Texas, however they are spreading to the eastern United States, including North Carolina, West Virginia, Ohio, and Tennessee. The species has also been reported in Kentucky, however not listed on the KY Exotic Pest Plant Council's lists yet. The species has very little ecological value other than providing a food source for squirrels. Many animals have been known to choke and suffocate on the large fruit referred to as "hedge apples" or "monkey balls". It is rare that this species would invade the site being that most are planted by residents for various reasons; therefore, we can remove this statement from the mitigation plan. If the tree is noticed during any site visits or monitoring, however, it should immediately be reported and removed.

Bullet 8 Section 7.2.1.2 states that side slopes were "set at a 2:1 slope to increase the width to depth ratio, lower the risk of erosion, and aid in the establishment of vegetation." It is not clear how a 2:1 slope accomplishes lowering the risk of erosion and aiding in the establishment of vegetation. Regarding the former, steep side slopes are at a greater risk for returning to a vertical or near vertical bank, because a smaller amount of erosion at the toe is necessary to create this condition (a more gentle slope can accommodate more lateral migration before the side slope is lost and all that remains is a steep bank elevation equal to or a greater than the bankfull elevation). Regarding the later, 2:1 slopes mean that there is less area for vegetation to make contact with the alluvial aquifer. 2:1 slopes can quickly isolate vegetation on the adjacent bank from the groundwater beneath, suspending vegetation above it. This reduces root activity within the banks, and decreases the bank resistance to erosion. Please discuss alternative side slopes, and/or provide additional assurances of slope stability. Please discuss groundwater interaction with bank and floodplain vegetation, and how this can be incorporated into restoration goals.

A low W/D ratio was needed for sediment transport competency. However, we didn't want to go too low so as to create a steep bank (1.5 to 1 or steeper). Typically, this is a best fit analysis. A 2 to 1 slope is not considered steep for natural channels, and this site has large material in the banks (e.g., gravel and cobble) which minimizes erosion potential. Additionally, when compared to the Bank Erosion Hazard Index (BEHI) criteria, a 2 to 1 slope (approximately 27°) falls well within the Low Bank Erosion Potential category. In addition, we have constructed hundreds of projects using a 2 to 1 slope. Monitoring results have showed that this bank slope, and the corresponding W/D ratio of 12 provides a good combination of bank stability and sediment transport capacity.

The depth to water table will not change with a change in bank angle or side slope. The depth to water table is controlled by the maximum bankfull depth. The design requires the bankfull benches and floodplain to be graded at the bankfull depth.

Bullet 9 At present, the design calls for the channel and surrounding "floodprone" area to be isolated from the adjacent terrace. It appears by examination of Figure 3.2 that in some cases (Reach 1), the flood storage area will actually decrease as a result of restoration. Because of this proposed isolation from the surrounding terrace, and the considerable depth over channel bottom anticipated during a storm event, the following calculation is needed:

Provide an analysis of shear stress values anticipated during a 100 year storm event. Shear stress values should be provided for the channel bed, banks, and unforested floodplain areas. Manning's n values should also be provided. If, in your determination, the values produced through this analysis constitute a risk to restoration success, please identify strategies to further reduce shear stress values (further floodplain excavation, etc.).

Peak flows, Q_2, Q_{50}, and Q_{100}, were estimated from the USGS Regional Regression Equations as detailed in Water-Resources Investigations (WRI), Reports 03-4180 (Kentucky) (See attached graph showing the regression lines for Reach 1 and 2, Exhibit No. 1). Those discharges were used to correlate the discharges that were generated in WinXSPro from the cross-sections that are located in Figure 3.2 of the Mitigation Report for Schultz Creek. Using the discharges from the regression equations, we were able to determine the stage and shear stresses for peak flows for the left floodplain, channel, and right floodplain sections. The results of this analyses are shown in Exhibit 3 and described below.

Reach 1 had three cross-sections (xsec) that were analyzed: the existing xsec, the design xsec from Fig. 3.2 of the Mitigation Report, and a design xsec that shows an average width of the floodplain (~63' on the left floodplain) (See Exhibit No. 2). The design xsec from Fig. 3.2 did not completely represent the floodplain and its storage area that is shown on the design plans. The average floodplain along the left side of the channel is approximately 40' wider than that shown on Fig 3.2 in the Mitigation Report. However, there is not a large difference in the shear stresses between the two design xsecs for Reach 1.

Both design xsecs from Reach 1 show an increase in shear stress at the bankfull discharge (Q_{bkf}) versus the existing discharge; however, this is needed to increase the sediment transport competency and capacity in order to move sediment through the system, since the current stream reach is aggradational. The total shear stress increases as the discharge increases which is due to the confinement of the flow between the terraces. However, the total shear stress for the 100 year flow is lower within both design xsecs than the existing xsec for Reach 1.

For Reach 2, the bankfull discharge for the typical riffle design cross section shows a higher shear stress than the existing cross section, which is a similar result as Reach 1. Again, this is to improve sediment transport competency and capacity. However, unlike Reach 1, shear stresses for flows greater than the bankfull discharge show a decrease in shear stress. This is because the floodplain in Reach 2 is much wider than in Reach 1.

Baker uses several methods to provide stability until natural processes evolve to provide long-term stability and function to the system. These methods include using vegetation (transplants), coir fiber (C7) matting, seeding, and live stakes along the stream banks. In addition, in-stream structures are used to reduce energy along the streambanks and to provide grade control. These techniques are described in more detail below.

The existing stream channel has alders and sycamore trees that can be transplanted during construction to stabilize the area adjacent to the stream channel. During construction, the channel length (work area) which can be disturbed by the Contractor will be limited by that length which can be vegetated at the end of the work day. Immediately after the channel has been prepared to design grades, the stream banks will be seeded and mulched. Then the coir fiber matting will be installed to temporarily stabilize the banks until the permanent vegetation is established. The coir fiber matting can withstand velocities of 11 fps, which is higher than the velocity associated with the 100 year discharge. The in-stream structures; such as cross vanes, single vanes, J-hooks, and rootwads; are not only used for habitat, but for initial bank stability. These structures deflect the flow away from the banks back toward the center of the channel.

Bullet 10 The bedload of Schultz Creek is characteristic of many tributaries of Tygarts Creek. This bedload, in addition to floodplain entrenchment, has resulted in failures and problems with other stream restoration projects that are similarly situated. Although the exact problems surrounding these failures may be complicated, it appears that one key issue has been a reliance on structures to center flow and pass bedload. The failure of these structures to completely pass the bedload has resulted in aggradation below and within structures, allowing them to be bypassed laterally. Adjacent banks are then at risk for erosion. Please discuss this issue, and other design considerations that relate to bedload. Have alternative options (such as material storage or splay) been examined to manage bedload volume? The Kentucky Division of Water is responsible for ensuring the integrity of all waters of the Commonwealth. As a result, a proposal that has benefits beyond the restoration area (potentially including reduction of sediment load) is preferred.

The problem with the failed project(s) may be related more to an issue of forcing pattern into a confined valley. It is imperative that the appropriate stream type be designed for the given valley type. Similarly the channel must be sized properly.

Our design considerations for bedload include:

1. ***A cross sectional area, depth, and slope have been designed to transport larger particles than would have been if there were regional curves and historical performance data. In other words, we are erring on the side of caution, by having a stream that is more competent than may be needed. The risk here is incision and we deal with this risk by preventing degradation with structures.***
2. ***In-stream structures provide grade control and create bedform diversity - pools. They also encourage deposition along the bank toe and form lateral bars rather than mid channel bars. And over time the channel becomes smaller, which is a positive change.***
3. ***Structures are designed after a proper geometric design.***

References

Hey, R.D., 2006. Fluvial Geomorphological Methodology for Natural Stable Channel Design. Journal of the American Water Resources Association. AWRA. Vol. 42, No 2, pp 357-374.

Very truly yours,

MICHAEL BAKER JR., INC.

Patrick W. Fogarty, P.E., P.S.

Enclosure

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